Patent Claims

1. Vessel propulsion system with a propulsion device (6) immersed at least partially in water, whereby such propulsion device (6) rotates at least about one axis of rotation essentially extending perpendicularly to the direction of propulsion, and with a cover (8) partially enclosing the propulsion device (6), which, together with the propulsion device (6), forms a water conveying flow channel when such propulsion device (6) is operated.

2. Vessel propulsion system according to Claim 1, **characterised in that** the propulsion device comprises a rotatably driven wheel (6).

3. Vessel propulsion system according to Claim 1, **characterised in that** the propulsion device comprises a rotatably driven revolving belt.

4. Vessel propulsion system according to Claim 1, **characterised in that** the propulsion device (6) exhibits a circumferentially closed circumferential surface.

5. Vessel propulsion system according to Claim 1, **characterised in that** the circumferential surface of the propulsion device (6) is bordered on its sides by bounding elements (42, 44) protruding beyond such circumferential surface and extending almost up to the cover.

6. Vessel propulsion system according to Claim 5, **characterised in that** the bounding elements and the cover are arranged stationarily.

7. Vessel propulsion system according to Claim 5, **characterised in that** the bounding elements (42, 44) are connected to the rotating propulsion device (6).

8. Vessel propulsion system according to Claim 1, **characterised in that** the outer circumferential surface of the propulsion device (6) has several teeth (46) arranged one behind the other.

9. Vessel propulsion system according to Claim 8, **characterised in that** each tooth (46) has a leading edge (50) directed radially outwards and a trailing edge (52) extending therefrom, directed radially inwards, and the leading edge (50) has a gradient lower than that of the trailing edge (52).

10. Vessel propulsion system according to Claim 9, **characterised in that** the tooth tip (48) of the teeth (46) is formed as a convex curvature in the axial direction.

11. Vessel propulsion system according to Claim 10, **characterised in that** the leading edge (50) and/or the trailing edge (52) of the teeth (46) are formed as a convex curvature in the axial direction.

12. Vessel propulsion system according to Claim 11, **characterised in that** the leading edge (50) and/or the trailing edge (52) of the teeth are formed as a convex curvature in the circumferential direction.

13. Vessel propulsion system according to Claim 1, **characterised in that** a rear end (14) of the cover (8) forming the inlet for the flow channel has a curvature directed forwards.

14. Vessel propulsion system according to Claim 1, **characterised in that** the front end (12) of the cover forming the outlet for the flow channel has a curvature directed backwards.

15. Vessel propulsion system according to Claim 1, **characterised in that** the upper edge of the cover (8) is arranged above the waterline (W) of the vessel (2) and the front and/or rear ends (12, 14) of the cover (8) extend below the waterline (W).

16. Vessel propulsion system according to Claim 1, **characterised in that** the cover extends with an enclosure angle of between 200° and 270° about the propulsion device (6).

17. Vessel propulsion system according to Claim 1, **characterised in that** between the propulsion device (6) and the cover a minimal gap (54) is formed of 2% to

10%, preferably 3% to 6%, of the diameter of the surrounding propulsion device (6).

18. Vessel propulsion system according to Claim 1, **characterised in that** the propulsion device (6) is, perpendicular to its axis of rotation (10), rotatable about a steering axis (S) and a control device is provided to control the rotation of the propulsion device (6) about the steering axis.

19. Vessel propulsion system according to Claim 18, **characterised in that** the propulsion device (6) together with the cover (8) are arranged on a support plate (68) through which the propulsion device (6) protrudes, whereby the upper surface of the support plate is sealed by a hood (34) and the support plate is accommodated in a pan (58) with an open bottom and such pan is rotatably supported in the vessel hull (16) and the propulsion device (6) protrudes through the pan (58) and a seal (72) is provided between the support plate (68) and the pan (58).

20. Vessel propulsion system according to Claim 19, **characterised in that** the hood (34) forms the cover (8).

21. Vessel propulsion system according to Claim 20, **characterised in that** the support plate (68) is, using at least one in-line inclination attenuator (82), supported on the pan (58) such that it can be pivoted.

22. Vessel propulsion system according to Claim 1, **characterised in that** a gap adjusting device is provided for adjusting the propulsion device relative to the cover.

23. Vessel propulsion system according to Claim 1, **characterised in that** it exhibits an immersion depth adjustment device for adjusting the height of the propulsion device and the cover.

24. Vessel propulsion system according to Claim 1, **characterised in that** a float (64) is provided on the front ends of the propulsion device (6) in each case and such

float tapers down preferably in the axial direction of the axis of rotation (10), away from the propulsion device (6).

25. Vessel propulsion system according to Claim 24, **characterised in that** the floats (64) are supported in a freely rotatable manner on the axis of rotation (10) or on the drive shaft (22) of the propulsion device (6).

26. Vessel propulsion system according to Claim 25, **characterised in that** on the radial outer end of the propulsion device (6) a thickening (80) is provided which is connected to the propulsion device (6) and which covers the propulsion device (6) in a mushroom-head shaped manner and which, at least partially, circumferentially protrudes beyond the float (64).

27. Vessel propulsion system with a driven, toothed propulsion wheel, which dips partly into the water, the rotational axis of which essentially extends at right angles to the direction of propulsion of the vessel propulsion system, and with a cover partially circumferentially enclosing the propulsion wheel, the said cover being arranged in relation to the propulsion wheel (100) such that during operation of the vessel propulsion system a flow circulating in the rotational direction of the propulsion wheel forms between the circumferential surface of the propulsion wheel (100) and the cover, **characterised in that** the leading and trailing faces (104, 106) of each of the teeth (102) formed on the propulsion wheel exhibit a spherical, convex surface, the tooth tip of each tooth (102) is curved convexly in the axial direction and the starting point of the radii of curvature of the spherical surfaces and the contour of the tooth tip (112) are located in a plane extending orthogonally to the rotational axis of the toothed wheel, the said plane also including the centre point of the propulsion wheel (100) in the axial direction.

28. Vessel propulsion system according to Claim 27, **characterised in that** the spherical surfaces and the tooth tip (112) have approximately the same radius of curvature.

29. Vessel propulsion system according to Claim 28, **characterised in that** the radii of curvature of the spherical surfaces and the tooth tip (112) vary at the most by 20%, preferably at the most by 10% about a mean formed from the three radii of curvature.

30. Vessel propulsion system according to Claim 27, **characterised in that** the starting point of the radius of curvature of each of the trailing faces (106) is essentially located on a circular shaped envelope area containing the tooth tips (112).

31. Vessel propulsion system according to Claim 27, **characterised in that** the starting point of the radii of curvature of each of the leading faces (104) is located on a circle which is situated concentrically to the rotational axis of the propulsion wheel (100) and between a circular area containing each tooth base (108, 110) and the rotational axis.

32. Vessel propulsion system according to Claim 31, **characterised in that** the radius of the circular area is 0.5 to 0.8 of the distance between the rotational axis and the envelope area containing the tooth base (108, 110).

33. Vessel propulsion system according to Claim 27, **characterised in that** the tooth tip (112) is spaced, with a perpendicular distance of 0.08 to 0.12 of the average mean of the three radii of curvature, from a radial line cutting the rotational axis and the tooth base (108) to the trailing face (106) of the corresponding tooth tip (112).

34. Vessel propulsion system with a driven, toothed propulsion wheel (100), which partly dips into the water, the rotational axis of which essentially extends at right angles to the propulsion direction of the vessel propulsion system and is arranged with a cover (126) partly enclosing the propulsion wheel (100) circumferentially such that with the operation of the vessel propulsion system a flow, circulating in the rotational direction of the propulsion wheel (100), is formed between the circumferential surface of the propulsion wheel (100) and the cover (126),

especially according to one of the previous claims, **characterised in that** gusset channels (140), which are formed between adjacent teeth of the propulsion wheel on its circumferential surface, open axially outwards to an intervening space (138) between the propulsion wheel (100) and the side surfaces (116, 118) of a housing (120) enclosing the propulsion wheel (100) and containing the cover (126).

35. Vessel propulsion system according to Claim 34, **characterised in that** the leading and trailing faces (104, 106) are essentially formed the same geometrically and that the inlet and outlet apertures (128, 130) of the gap (132) are located at about the same height.

36. Vessel propulsion system according to Claim 34, **characterised in that** the ratio of the volume of the intervening space (138) to the volume of the gap (132) is between 0.75 and 2.00, preferably between 0.9 and 1.1.

37. Vessel propulsion system according to Claim 34, **characterised in that** the distance between the side surfaces of the propulsion wheel (100) and the side surfaces (116, 118) of the housing corresponds at least to half the axial extension of the propulsion wheel (100).

38. Vessel propulsion system according to Claim 34, **characterised in that** a drive shaft (114) of the propulsion wheel (100) protrudes through the side surfaces (116, 118), which side surfaces carry bearings (12,124) for supporting the drive shaft (114).

39. Vessel propulsion system according to Claim 34, **characterised in that** the cover (126) encloses the propulsion wheel (100) with an enclosure angle of between 200° and 300° and a region of the cover (126), forming the outlet aperture (130) for the flow in the main propulsion direction of the vessel propulsion system, encloses the propulsion wheel (100) so far that the flow is ejected mainly parallel to the propulsion direction, whereas a region of the cover (126) forming the inlet (128) of the hydrodynamic drive for the flow in the main drive direction draws in the flow essentially with a speed extending perpendicular to the propulsion direction

into a gap (132) formed between the cover (126) and the circumferential surface of the propulsion wheel (100) and that the propulsion wheel (100) exhibits ring-shaped cheeks (136) protruding beyond the tooth base (108) on both of its face sides.

40. Vessel propulsion system according to Claim 39, **characterised in that** the cheeks (136) extend to about the highest point of the tooth tips (112).

41. Vessel propulsion system according to Claim 34, **characterised in that** the gap (132) in the region of the outlet aperture (130) tapers in the main direction of propulsion.

42. Vessel propulsion system according to Claim 34, **characterised in that** the gap in the region of the inlet aperture (128) is widened funnel-shaped.

43. Vessel propulsion system according to Claim 34, **characterised in that** the gap (132) has a constant gap height over 90% to 95% of the enclosure angle essentially in the circumferential direction.

44. Vessel propulsion system according to Claim 34, **characterised in that** the gap (132) in its section constant in the circumferential direction, measured from the radially outermost point of the tooth tip (112), has a height to the cover (126) of 0.08 to 0.12, preferably from 0.09 to 0.11 of the mean of the three radii of curvature.

45. Vessel propulsion system with a driven, toothed propulsion wheel (100), which partly dips into the water, the rotational axis of which essentially extends at right angles to the propulsion direction of the vessel propulsion system and is arranged with a cover (126) partly enclosing the propulsion wheel (100) circumferentially such that with the operation of the vessel propulsion system a flow, circulating in the rotational direction of the propulsion wheel (100), is formed between the circumferential surface of the propulsion wheel (100) and the cover (126), particularly according to one of the previous claims, **characterised in that** gusset channels (140), which are formed between adjacent teeth of the propulsion wheel

on its circumferential surface, open axially outwards to an intervening space (138) between the propulsion wheel (100) and the side surfaces (116, 118) of a housing (120) enclosing the propulsion wheel (100) and containing the cover (126), the leading and trailing faces (104, 106) of each of the teeth (102) formed on the propulsion wheel exhibit a spherical, convex surface, the tooth tip of each tooth (102) is curved convexly in the axial direction and the starting point of the radii of curvature of the spherical surfaces and the contour of the tooth tip (112) are located in a plane extending orthogonally to the rotational axis of the toothed wheel, the said plane also including the centre point of the propulsion wheel (100) in the axial direction.

46. Vessel propulsion system according to Claim 45, **characterised in that** the spherical surfaces and the tooth tip (112) have approximately the same radius of curvature.

47. Vessel propulsion system according to Claim 45, **characterised in that** the radii of curvature of the spherical surfaces and the tooth tip (112) vary at the most by 20%, preferably at the most by 10% about a mean formed from the three radii of curvature.

48. Vessel propulsion system according to Claim 45, **characterised in that** the starting point of the radius of curvature of each of the trailing faces (106) is essentially located on a circular shaped envelope area containing the tooth tips (112).

49. Vessel propulsion system according to Claim 45, **characterised in that** the starting point of the radii of curvature of each of the leading faces (104) is located on a circle which is situated concentrically to the rotational axis of the propulsion wheel (100) and between a circular area containing each tooth base (108, 110) and the rotational axis.

50. Vessel propulsion system according to Claim 49, **characterised in that** the radius of the circular area is 0.5 to 0.8 of the distance between the rotational axis and envelope area containing the tooth base (108, 110).

51. Vessel propulsion system according to Claim 45, **characterised in that** the tooth tip (112) is spaced, with a perpendicular distance of 0.08 to 0.12 of the average mean of the three radii of curvature, from a radial line cutting the rotational axis and the tooth base (108) to the trailing face (106) of the corresponding tooth tip (112).

52. Vessel propulsion system according to Claim 45, **characterised in that** the leading and trailing faces (104, 106) are essentially formed the same geometrically and that the inlet and outlet apertures (128, 130) of the gap (132) are located at about the same height.

53. Vessel propulsion system according to Claim 45, **characterised in that** the ratio of the volume of the intervening space (138) to the volume of the gap (132) is between 0.75 and 2.00, preferably between 0.9 and 1.1.

54. Vessel propulsion system according to Claim 45, **characterised in that** the distance between the side surfaces of the propulsion wheel (100) and the side surfaces (116, 118) of the housing corresponds at least to half the axial extension of the propulsion wheel (100).

55. Vessel propulsion system according to Claim 45, **characterised in that** a drive shaft (114) of the propulsion wheel (100) protrudes through the side surfaces (116, 118), which side surfaces carry bearings (12,124) for supporting the drive shaft (114).

56. Vessel propulsion system according to Claim 45, **characterised in that** the cover (126) encloses the propulsion wheel (100) with an enclosure angle of between 200° and 300° and a region of the cover (126), forming the outlet aperture (130) for the flow in the main propulsion direction of the vessel propulsion system, encloses the propulsion wheel (100) so far that the flow is ejected mainly parallel

to the propulsion direction, whereas a region of the cover (126) forming the inlet (128) of the hydrodynamic drive for the flow in the main drive direction draws in the flow essentially with a speed extending perpendicular to the propulsion direction into a gap (132) formed between the cover (126) and the circumferential surface of the propulsion wheel (100) and that the propulsion wheel (100) exhibits ring-shaped cheeks (136) protruding beyond the tooth base (108) on both of its face sides.

57. Vessel propulsion system according to Claim 56, **characterised in that** the cheeks (136) extend to about the highest point of the tooth tips (112).

58. Vessel propulsion system according to Claim 45, **characterised in that** the gap (132) in the region of the outlet aperture (130) tapers in the main direction of propulsion.

59. Vessel propulsion system according to Claim 45, **characterised in that** the gap in the region of the inlet aperture (128) is widened funnel-shaped.

60. Vessel propulsion system according to Claim 45, **characterised in that** the gap (132) has essentially a constant gap height over 90% to 95% of the enclosure angle in the circumferential direction.

61. Vessel propulsion system according to Claim 45, **characterised in that** the gap (132) in its section constant in the circumferential direction, measured from the radially outermost point of the tooth tip (112), has a height to the cover (126) of 0.08 to 0.12, preferably from 0.09 to 0.11 of the mean of the three radii of curvature.